

(19) World Intellectual Property
Organization
International Bureau



04 MAR 2005



(43) International Publication Date
18 March 2004 (18.03.2004)

PCT

(10) International Publication Number
WO 2004/022328 A1

(51) International Patent Classification⁷: **B32B 3/12, 7/12**

(21) International Application Number:

PCT/SE2003/001353

(22) International Filing Date:

1 September 2003 (01.09.2003)

(25) Filing Language:

Swedish

(26) Publication Language:

English

(30) Priority Data:

0202623-5 5 September 2002 (05.09.2002) SE

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(81) Designated States (*national*): AE, AG, AL, AM, AT (uti-
lity model), AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA,
CH, CN, CO, CR, CU, CZ (utility model), CZ, DE (utility
model), DE, DK (utility model), DK, DM, DZ, EC, EE, ES,
FI (utility model), FI, GB, GD, GE, GH, GM, HR, HU, ID,
IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT,
LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO,
NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK
(utility model), SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA,
UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

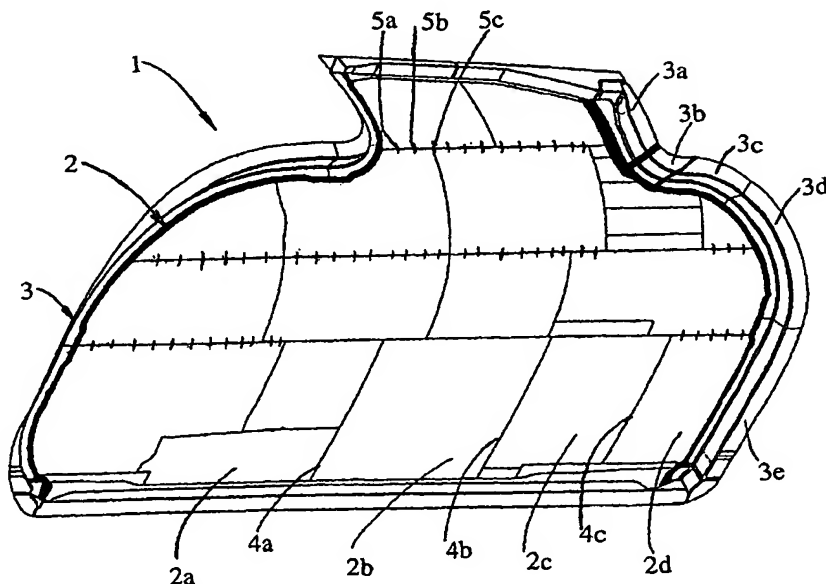
(84) Designated States (*regional*): ARIPO patent (GH, GM,
KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW),
Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE,
ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO,
SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM,
GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— as to applicant's entitlement to apply for and be granted
a patent (Rule 4.17(ii)) for the following designations AE,
AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA,
CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES,

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(54) Title: **METHOD FOR REINFORCING A CORE AND ARTICLE CONTAINING SAID CORE**



(57) Abstract: This invention concerns a method for reinforcing a core (2) constructed of at least two core parts (2a, 2b, 2c, 2d), each of which exhibits a top side, a bottom side and walls joining the top side and bottom side. The core parts (2a, 2b, 2c, 2d) are arranged joined wall-to-wall with one another along a joint seam (4a, 4b, 4c) filled with glue, preferably in the form of a glue film. The method is characterized in that notches (5a, 5b, 5c) are realized in a number of places in the glue joint, which notches extend between the walls from the top side to the bottom side of the core parts so that the glue joint can be divided into pieces. The invention also encompasses an article fabricated in accordance with the aforementioned method.

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FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations
- of inventorship (Rule 4.17(iv)) for US only

Published:

- with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Method for reinforcing a core and article containing said core

- 5 The invention concerns a method for reinforcing a core according to the preamble to Claim 1, and an article containing said core.

10 The fabrication of many articles and structural elements, such as vehicles, vessels and aircraft, out of sheet metal or hardenable composite materials containing fibers, such as glass fibers or carbon fibers, is known. Such composite materials are distinguished by high strength and relatively low weight. In typical cases a structural element comprises a shell of such composite material and a cell core, where the cell core has a honeycomb structure and is contained within the shell.

- 15 For fabrication-related reasons, the cell core often consists of a plurality of units of the cell-core type, which are joined together by means of gluing to form the cell core. The glue joints can however become overloaded during fabrication or operational use, so that the units at one or a plurality of extents along the glue joints are at risk of separating from one another. The strength of the cell core is thereby degraded significantly.

20 To gain access to a core inside an article in order to reinforce or repair the core in cases involving a double shell design, a hole must be made in some part of the shell. The holes made for purposes of repair must subsequently be patched. If the holes also entail that the shell becomes weakened, the shell must also be reinforced so that it can bear its loads. No effective methods for repairing glue joints currently exist. The methods used today are based on cutting out a portion of the cell core material at the glue joints, after which a repair section is inserted and glued securely in place. These methods involve major damage to the cell core material, and to at least one of the shells connected to the glue joints. Because it is difficult to harden the repaired area to the same strength as that of the desired cell core, the repair results in a degradation of the structure.

30 In summary, repairs of cell cores and consequent repairs to the shell are usually very expensive, and it is difficult to achieve satisfactory strength in both the cell core and the shell in which holes have been made.

- 35 One purpose of the present invention is to solve the problem of crack formation in glue joints in a manner that represents an improvement over the prior art. This is achieved according to an

embodiment of the invention by means of a method for reinforcing a core constructed of at least two core parts, each of which exhibits a top side, a bottom side and walls joining the top side and bottom side, wherein the core parts are arranged joined wall-to-wall with one another along a joint seam filled with glue, preferably in the form of a glue film. The method is characterized in that notches are realized in a number of places in the glue joint, which notches extend between the walls from the top side to the bottom side of the core parts so that the glue joint can be divided into pieces.

According to an embodiment of the invention, the glue joint is divided into 70 - 200mm-long units, whereby the division can occur at essentially right angles between the walls. According to a special embodiment, the glue joint is divided into 100 - 120mm-long units. The division can be realized by means of sawing or another suitable method so that a gap is formed between the glue joints.

The invention further comprises an article containing the aforesaid core, wherein the core parts are arranged wall-to-wall and joined with one another along a joint seam filled with glue. The article is characterized in that the glue joint contains notches that extend between the walls from the top side to the bottom side of the cell cores so that the glue joint can be divided into pieces.

The crack formation that the invention is intended to prevent is caused by the glue joint being more rigid than the core parts. Dividing the glue into smaller units creates play so that the glue joint can move, whereupon tensile stresses in the article will no longer cause cracks to form along the length of the glue joint.

The invention will now be clarified in greater detail by describing various exemplary embodiments, and with reference to the accompanying drawing, in which the figure depicts an article according to an exemplary embodiment of the invention.

In the figure, reference number 1 refers to an article. The article 1 can consists of a structural element for an airplane, a boat, a vessel, a vehicle or any other device, such as a machine or a building. The article 1 in the exemplary embodiment shown contains a core 2 and a frame 3 that surrounds that sides of the core and consists of a number of edge elements 3a, 3b, 3c, 3d and 3e. The article 1 can also contain a first sheet on which the core rests, and a second sheet arranged on top of the core 2, whereupon the core 2 is entirely contained by the sheets and the frame 3. For illustrative reasons, these sheets are however not depicted. The frame 3 and any such sheets are

made of sheet metal or composite material containing fibers, such as carbon fibers, glass fibers and/or other fibers. The core 2 has a cellular structure, by means of which the weight of the article can be kept at a low level, e.g. a honeycomb structure. The core 2 is, e.g. an aluminum core, a carbon fiber core or a core made of a phenol matrix and aramid fiber-paper. For

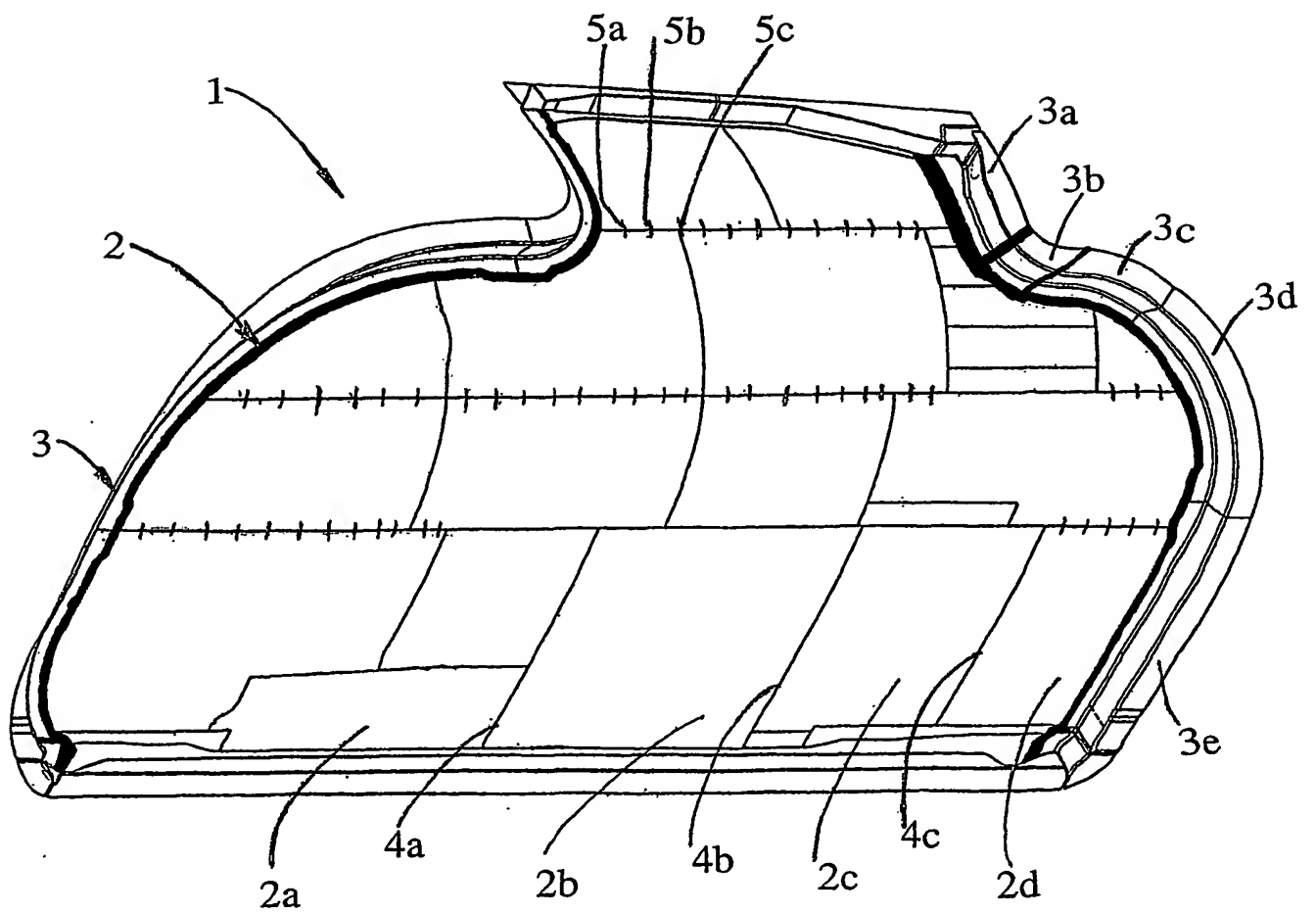
5 fabrication-related reasons, the core 2 usually consists of a plurality of parts 2a, 2b, 2c and 2d of a cell-core type. The core parts 2a, 2b, 2c and 2d are joined to one another via glue joints 4a, 4b and 4c to form the cell core 2. The glue used for the glue joints is, e.g. a foaming glue such as a foaming epoxy glue or a paste glue.

10 Transverse notches 5a, 5b and 5c are made in the glue joints. In the figure, only a fraction of the notches have reference designations, but the unnumbered notches are identical with the numbered ones. The notches 5a, 5b and 5c are made in the glue joints in order to reduce the stresses in the core 1 so as to thereby prevent longitudinal cracks from forming in the glue joints. The notches in the exemplary embodiment shown have been made in those glue joint sections
15 that are particularly exposed to stresses, while other, less exposed glue joint sections do not have such notches. The notches 5a, 5b, and 5c in the exemplary embodiment shown are oriented at right angles between two glued core part walls. In another embodiment, which is not shown, the grooves are not at right angles to the core part walls, but are rather made at another angle, e.g. 45°. The distance between the notches can be determined by the materials involved in the core
20 and the glue joints, i.e. how, for example, the rigidity and/or thermal expansion properties of the core stand in relation to those of the glue joints. The notches 5a, 5b and 5c are made at a distance of, e.g. 70 - 200mm from one another, e.g. 100 - 120mm apart. The notches 5a, 5b and 5c divide the glue joints entirely into pieces. The notches 5a, 5b and 5c are realized by means of sawing or another suitable method of dividing the glue joints, whereby a gap is obtained between the glue
25 joint parts.

CLAIMS

1. A method for reinforcing a core (2) constructed of at least two core parts (2a, 2b, 2c, 2d), each of which exhibits a top side, a bottom side and walls joining the top side and the bottom side, whereupon the core parts (2a, 2b, 2c, 2d) are arranged joined wall-to-wall with one another along a joint seam (4a, 4b, 4c) filled with glue, preferably in the form of a glue film, characterized in that notches (5a, 5b, 5c) are realized at a number of places in the glue joint, which notches extend between the walls from the top side to the bottom side of the core parts in order to divide the glue joint into pieces.
2. A method according to Claim 1, characterized in that the glue joint is divided into 70 - 200mm-long units.
3. A method according to Claim 2, characterized in that the glue joint is divided into 100 - 120mm-long units.
4. A method according to any of the foregoing claims, characterized in that the glue joint is sawn into pieces.
5. An article (1) containing a core (2) constructed of at least two core parts (2a, 2b, 2c, 2d), each of which exhibits a top side, a bottom side and walls joining the top side and the bottom side, whereupon the core parts (2a, 2b, 2c, 2d) are arranged joined wall-to-wall with one another along a joint seam (4a, 4b, 4c) filled with glue, preferably in the form of a glue film, characterized in that notches (5a, 5b, 5c) are made at a number of places in the glue joint, which notches extend between the walls from the top side to the bottom side of the core parts in order to divide the glue joint into pieces.
6. An article according to Claim 5, characterized in that the glue film is divided into 70 - 200mm-long units.
7. An article according to Claim 6, characterized in that the glue joint is divided into 100 - 120mm-long units.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 03/01353

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B32B 3/12, B32B 7/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4910065 A (M.E. MCKINNEY), 20 March 1990 (20.03.90), column 2, line 40 - column 3, line 18, figures 1,2 --	1,5
A	US 5876652 A (M.E. RORABAUGH ET AL), 2 March 1999 (02.03.99), column 1, line 41 - line 58; column 2, line 10 - line 16; column 3, line 5 - line 17, figures 1-6 --	1,5
A	US 6268049 B1 (J.J. CHILDRESS), 31 July 2001 (31.07.01), column 3, line 26 - line 47, figure 1 --	1,5



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

12 November 2003

Date of mailing of the international search report

21-11-2003

Name and mailing address of the ISA/

Swedish Patent Office

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 03/01353

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2267101 A (LJUBOMIR GNJATOVIC), 24 November 1993 (24.11.93), figures 1-5, abstract -- -----	1,5

INTERNATIONAL SEARCH REPORT

Information on patent family members

06/09/03

International application No.

PCT/SE 03/01353

Patent document cited in search report			Publication date	Patent family member(s)			Publication date
US	4910065	A	20/03/90	AU	2365488 A	20/04/89	
				BR	8805281 A	30/05/89	
				DK	575788 A	16/04/89	
				EP	0311931 A	19/04/89	
				JP	1214431 A	28/08/89	
				NO	884592 A	17/04/89	
				NZ	226519 A	26/06/90	

US	5876652	A	02/03/99	US	5869165 A	09/02/99	

US	6268049	B1	31/07/01	US	5958550 A	28/09/99	
				US	6027798 A	22/02/00	
				AU	7718896 A	22/05/97	
				US	5736222 A	07/04/98	
				US	5935680 A	10/08/99	
				WO	9716303 A	09/05/97	

GB	2267101	A	24/11/93	AU	3765893 A	08/11/93	
				GB	9206927 D	00/00/00	
				WO	9320300 A	14/10/93	